

# Interannual Variations of Surface Radiation

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# Objective of Study and Data Set

- To quantify the interannual variations of surface radiation using the NASA/GEWEX SRB Data Set.
- This data set includes Net Shortwave, Upward and Downward Longwave Fluxes with monthly averages on  $1^{\circ} \times 1^{\circ}$  grid for 1983-2005.

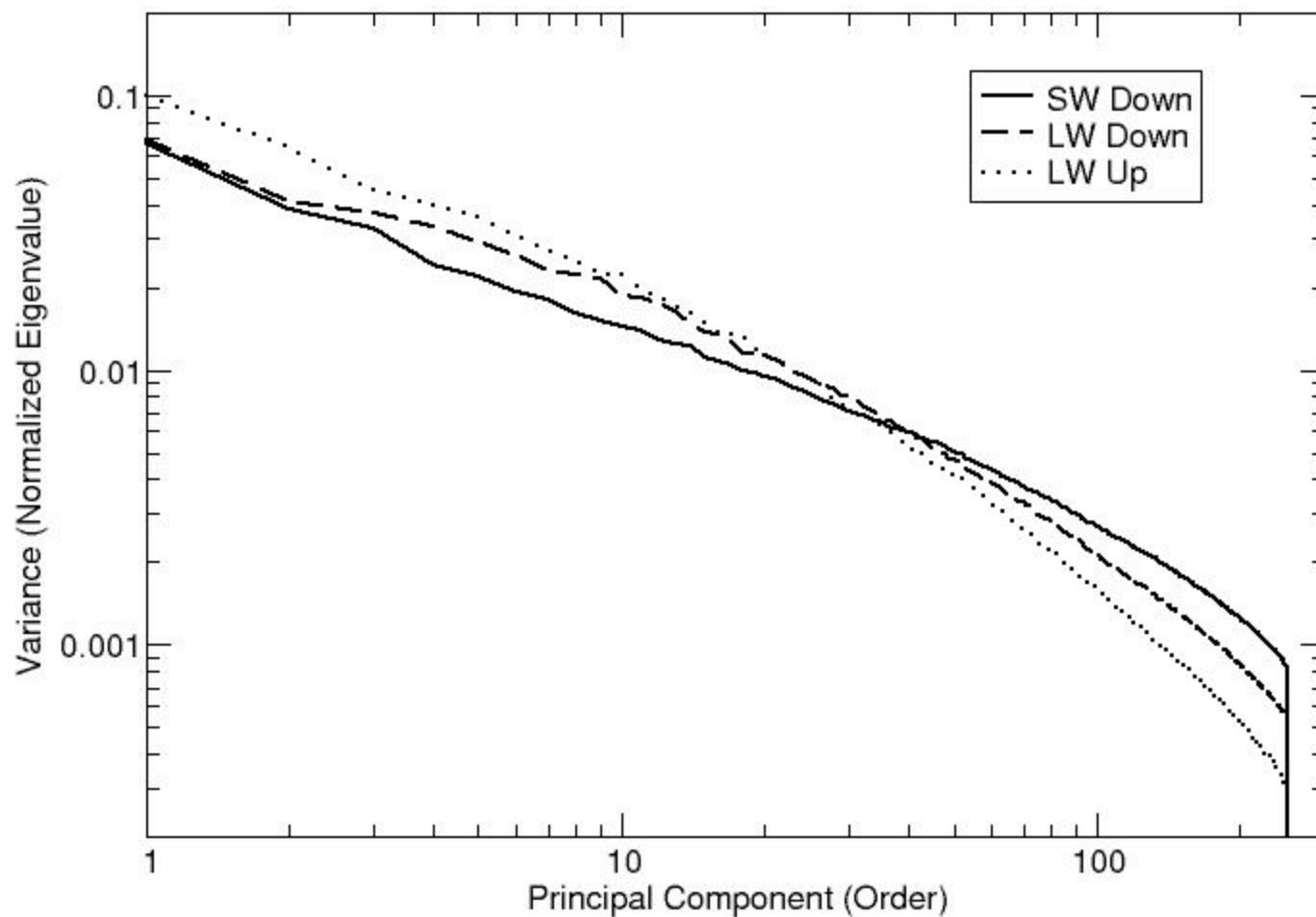
# Approach

- Compute climatological mean monthly values.
- Interannual variations are variations of value from the climatological-mean monthly value.
- Use Principal Component Analysis to compute variations as correlated in time.
- These Principal Components are projected onto map to give geographic variations which are correlated in time.

# Computations

- Principal Components are eigenvectors of Covariance Matrix of variations.
- Eigenvalues of Covariance Matrix define amount of variance described by each Principal Component.

## Variances from PC Analysis of SRB Interannual



# Power Law for RMS of Interannual Variations

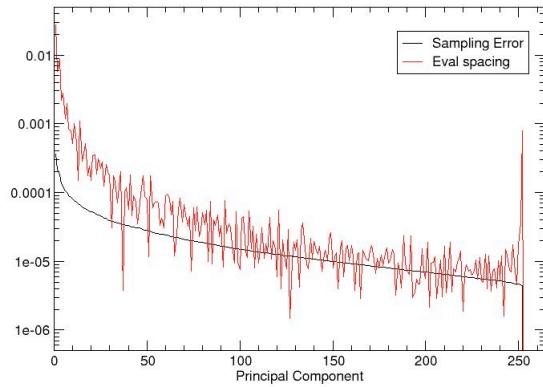
RMS, Shortwave Net       $\text{RMS}_n = 3.84n^{-0.32}$

RMS, Longwave Down     $\text{RMS}_n = 1.92n^{-0.30}$

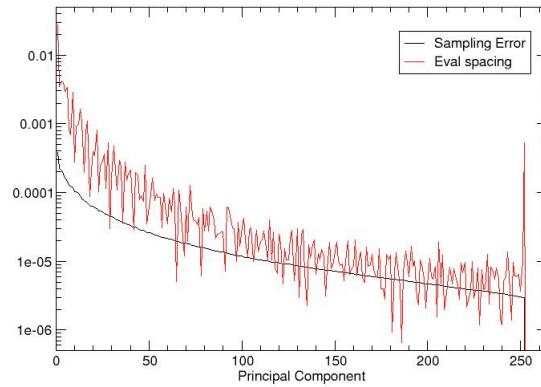
RMS, Longwave Up       $\text{RMS}_n = 2.16n^{-0.36}$   
W/m<sup>2</sup>

Parameter	SWD	LWD	LWU
$\lambda_1$	0.0663	0.0685	0.1001
$m$	0.65	0.60	0.73
RMS	14.9	6.8	7.3
RMS(1)	3.84	1.92	2.16
$p$	0.32	0.30	0.36

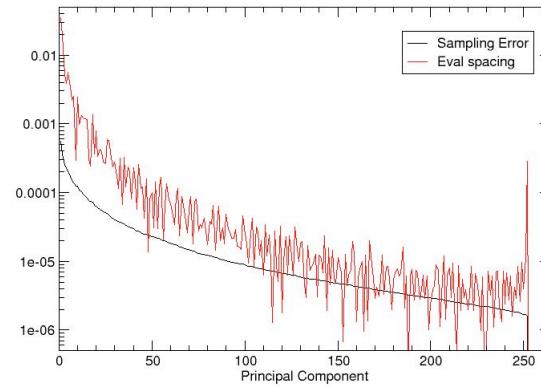
# Validity check of Principal Components: North et al. Criterion



Shortwave Down



Longwave Down



Longwave Up

There are ~40 Valid Principal Components  
for Each Radiation Flux

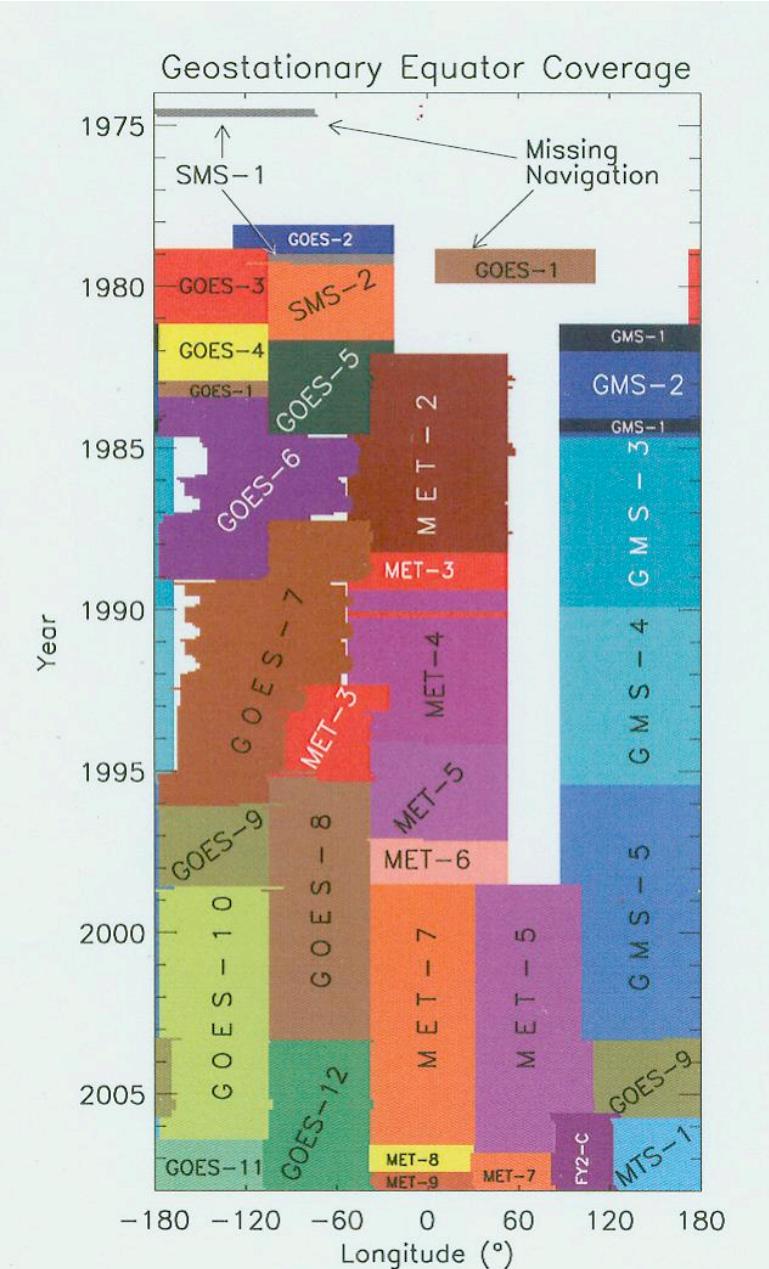


Fig. 1. Time series showing geostationary observations at the Equator.

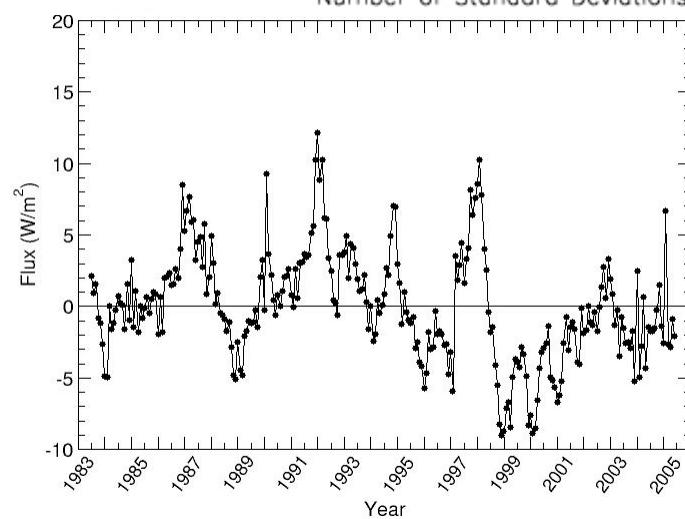
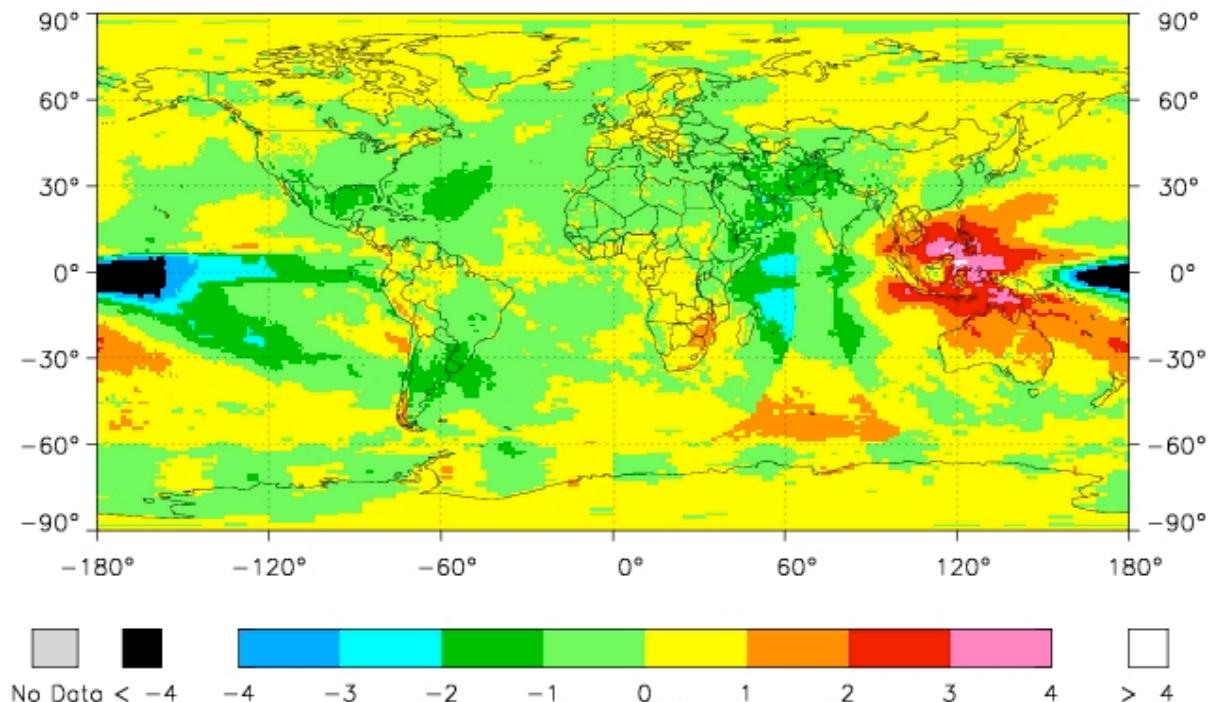
# Shortwave Downward Principal Components and EOFs

1	<b>ENSO</b>
2	<b>Artifact due to S/C</b>
3	<b>ENSO North-South variation</b>
4	<b>Indian Ocean Activity</b>
5	<b>Indian Ocean Activity</b>
6	<b>Indian Ocean Activity</b>
7	-
8	<b>Brazil Outflow</b>
9	<b>Indian Ocean and East Eq. Pacific</b>
10	<b>Phillipines</b>

# Longwave Downward Principal Components and EOFs

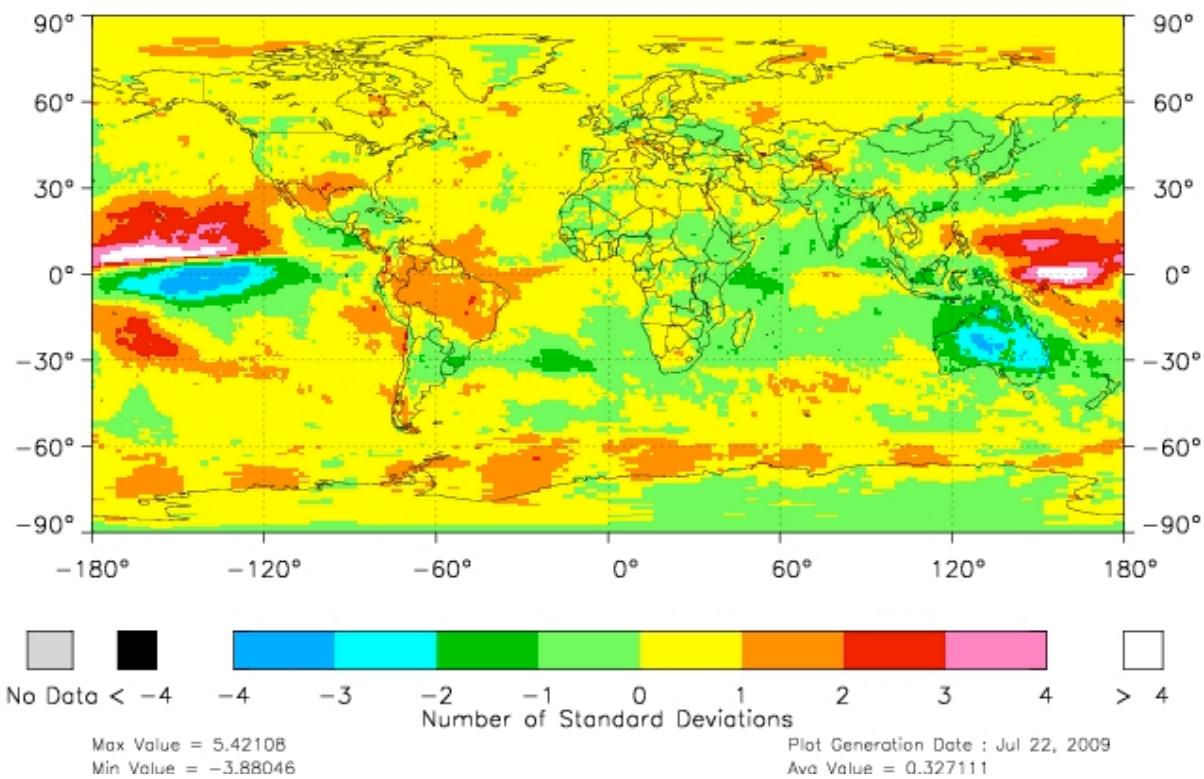
1	<b>ENSO and North Africa</b>
2	<b>N. Africa, E. Siberia, Eq. Pacific</b>
3	<b>Canada &amp; Australia</b>
4	<b>North America and Eurasia</b>
5	<b>High Latitudes North and South</b>
6	<b>High Latitudes North</b>
7	<b>High Latitudes North</b>
8	<b>High Latitudes North and Australia</b>
9	<b>High Latitudes North &amp; Africa/Asia</b>
10	<b>Random Patterns, but mostly all +</b>

# EOF-1 Downward Shortwave



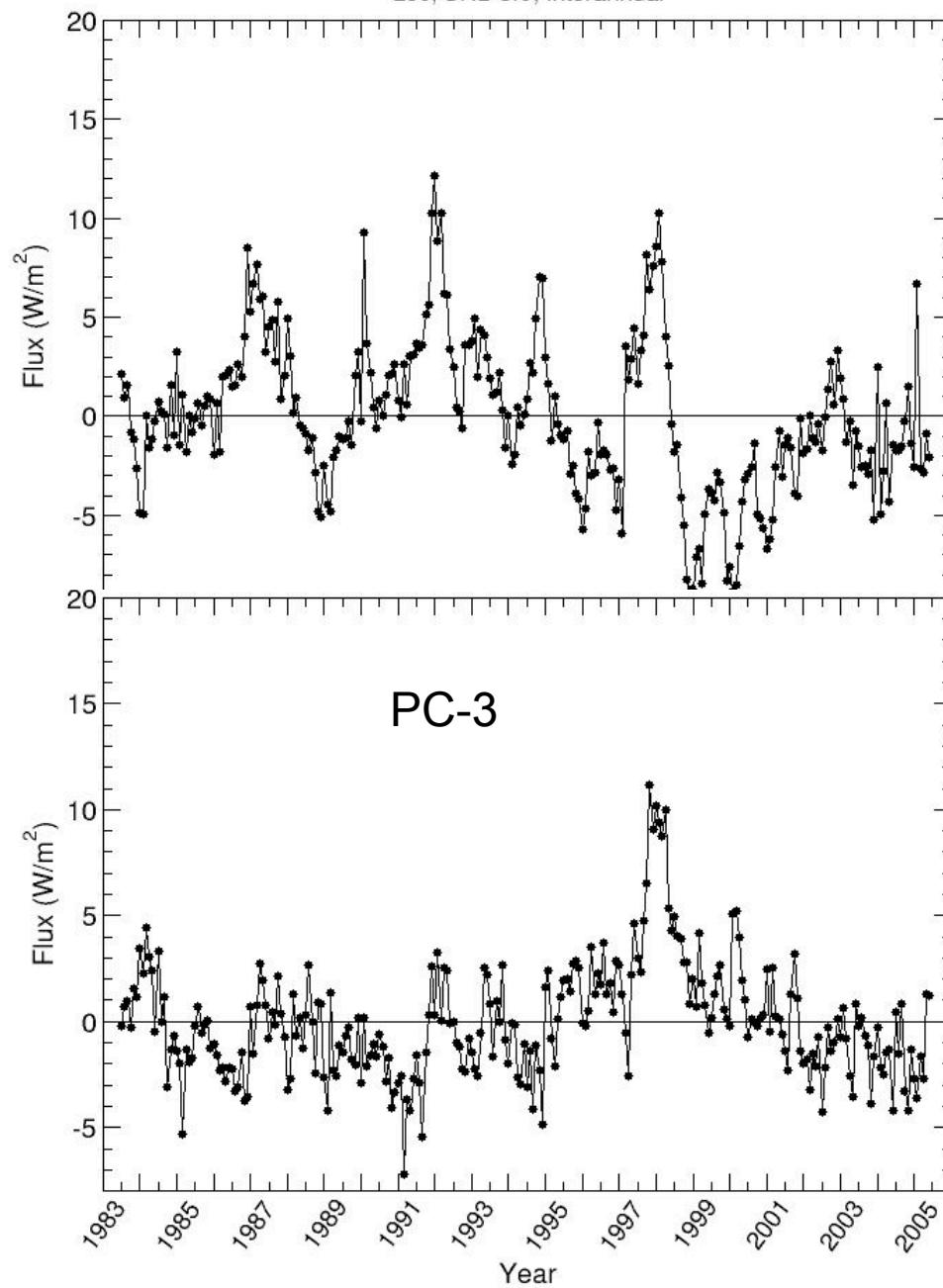
This EOF describes ENSOs  
but shows artifacts

SRB EOF-3 land/ocean  
Interannual 7/1983 – 6/2005  
INPUT FILE: evec\_SWdown\_loc.dat

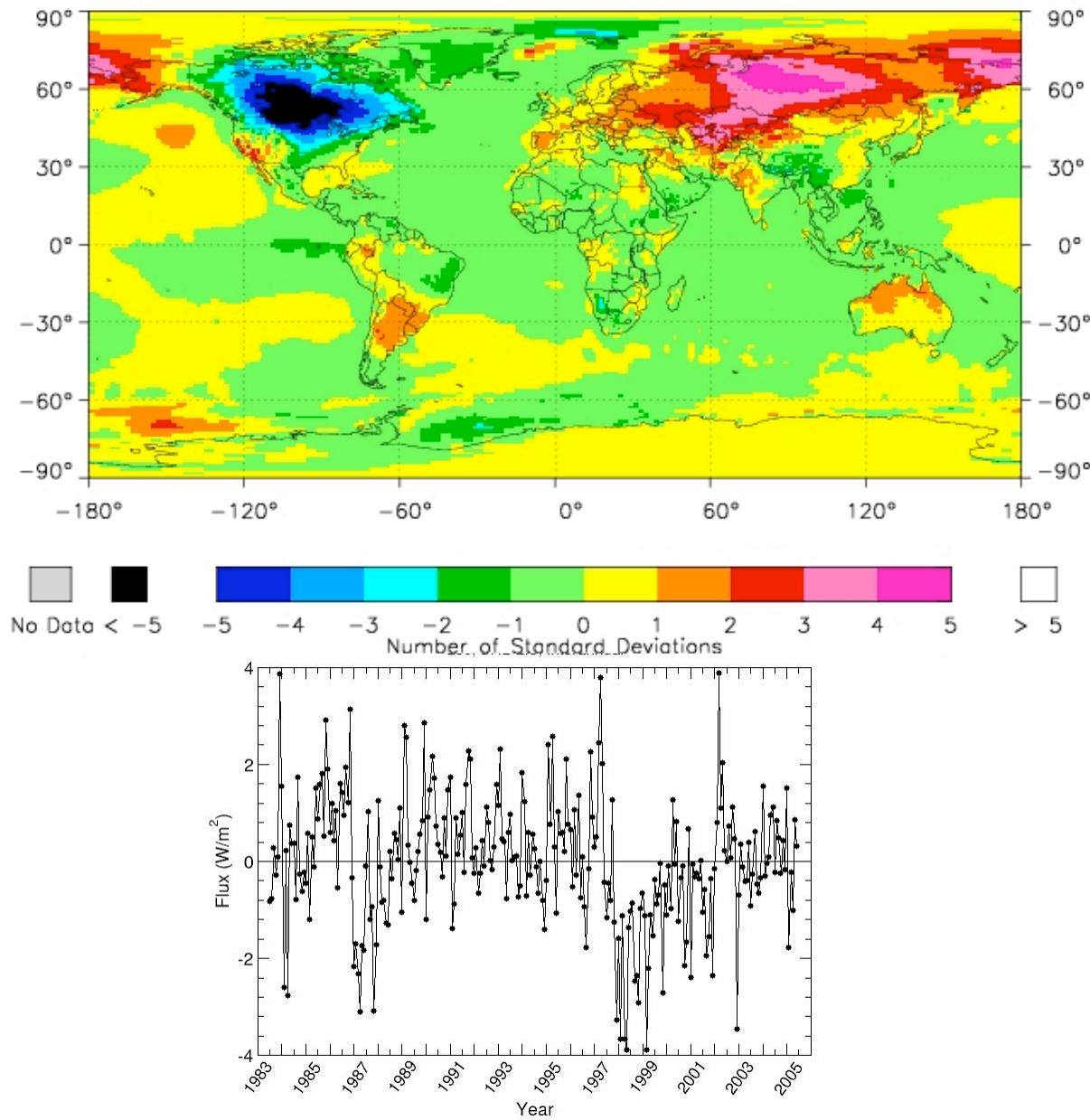


### PC-1 for SW Down

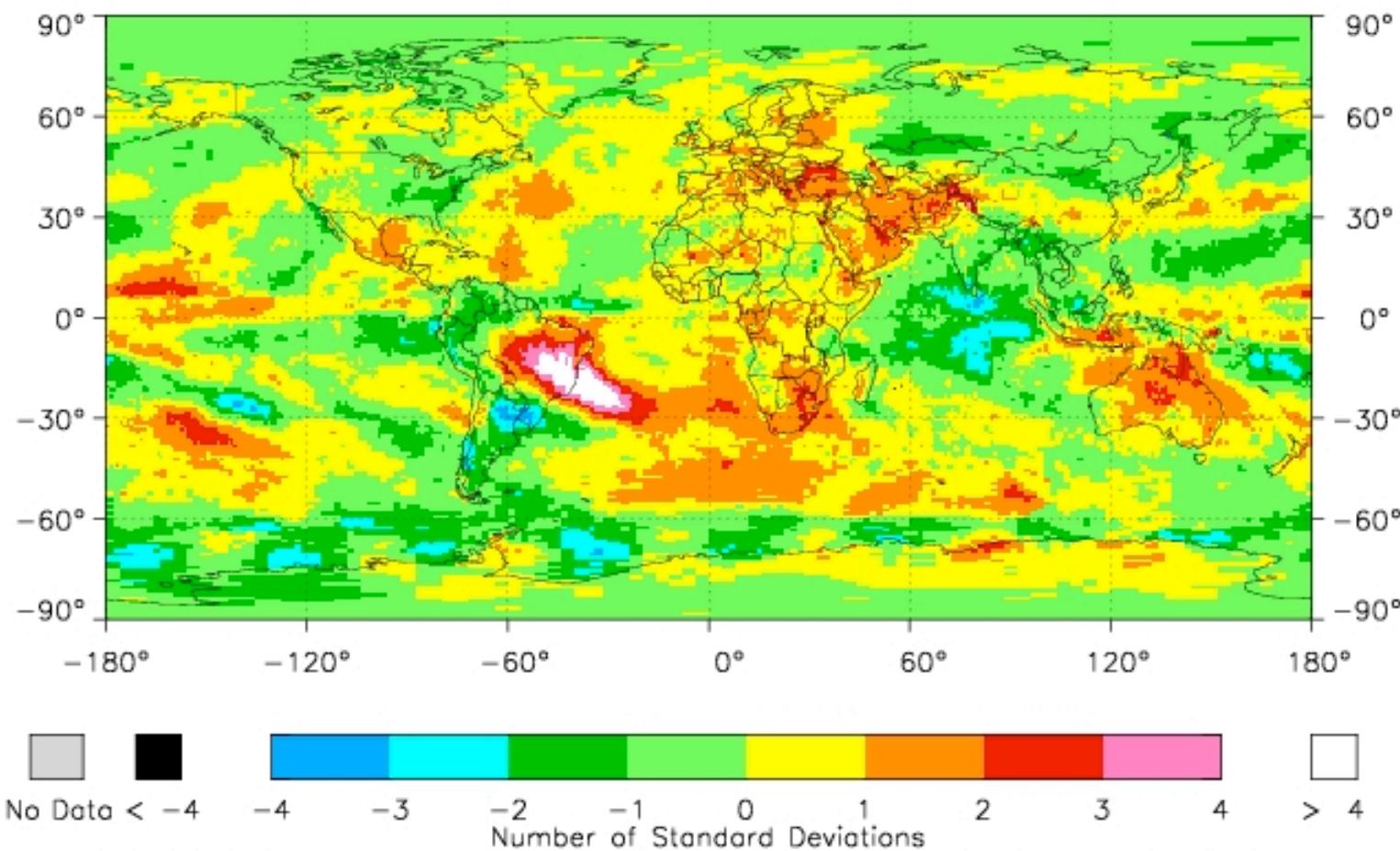
Loc: SRB 3.0; Interannual



# EOF-4 for Longwave Up

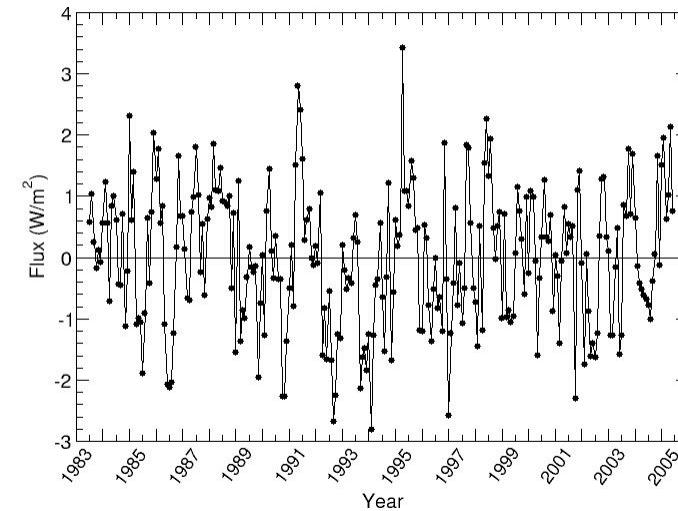
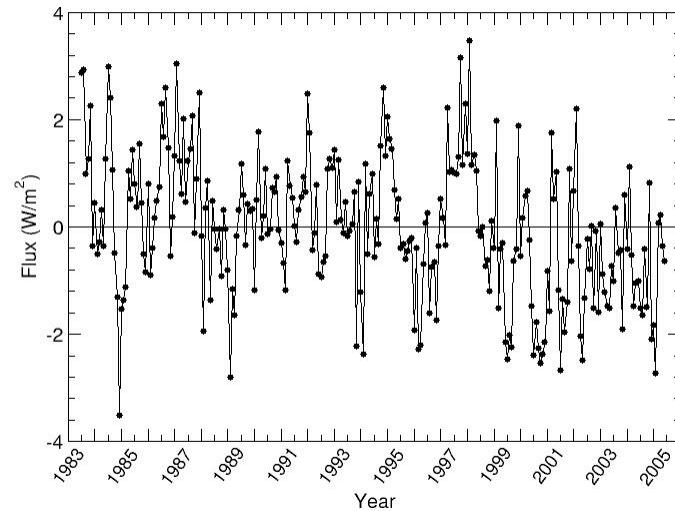
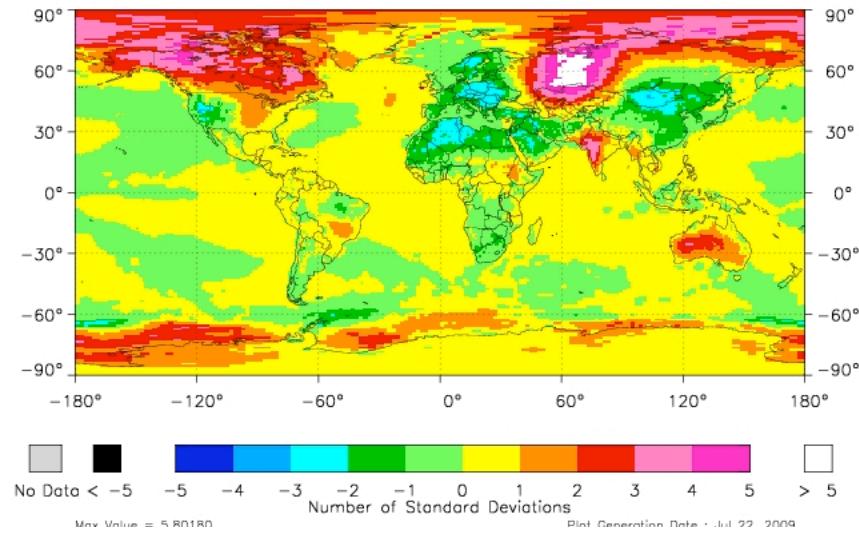
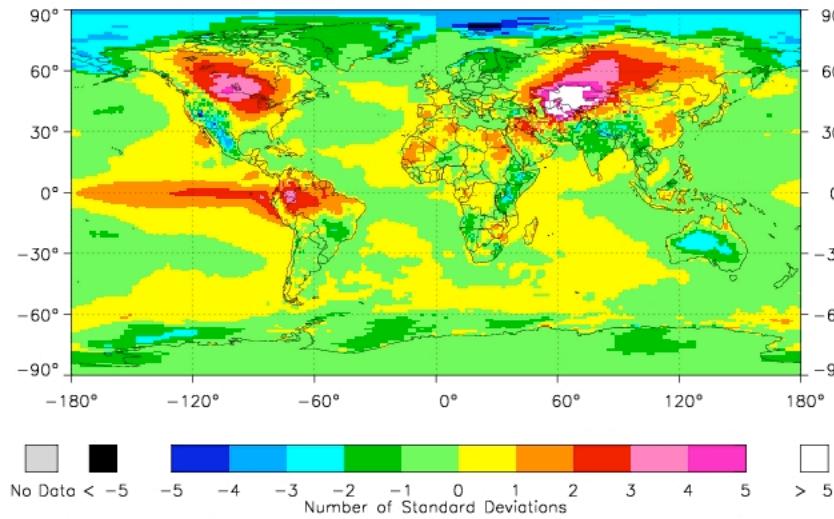


# EOF-8 Shortwave Down South Atlantic Convergence Zone

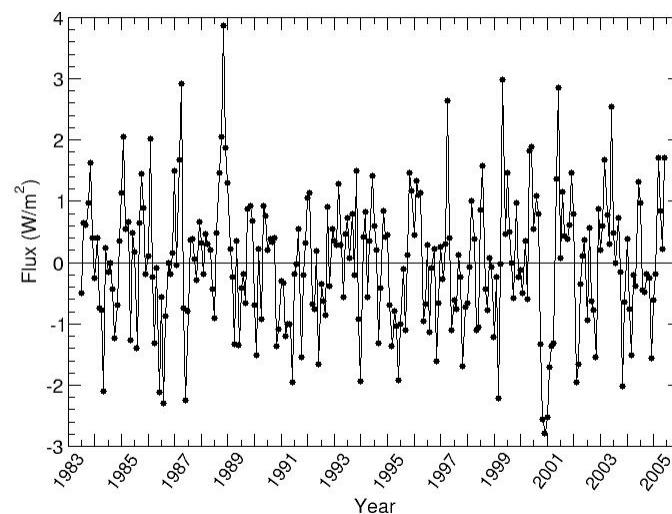
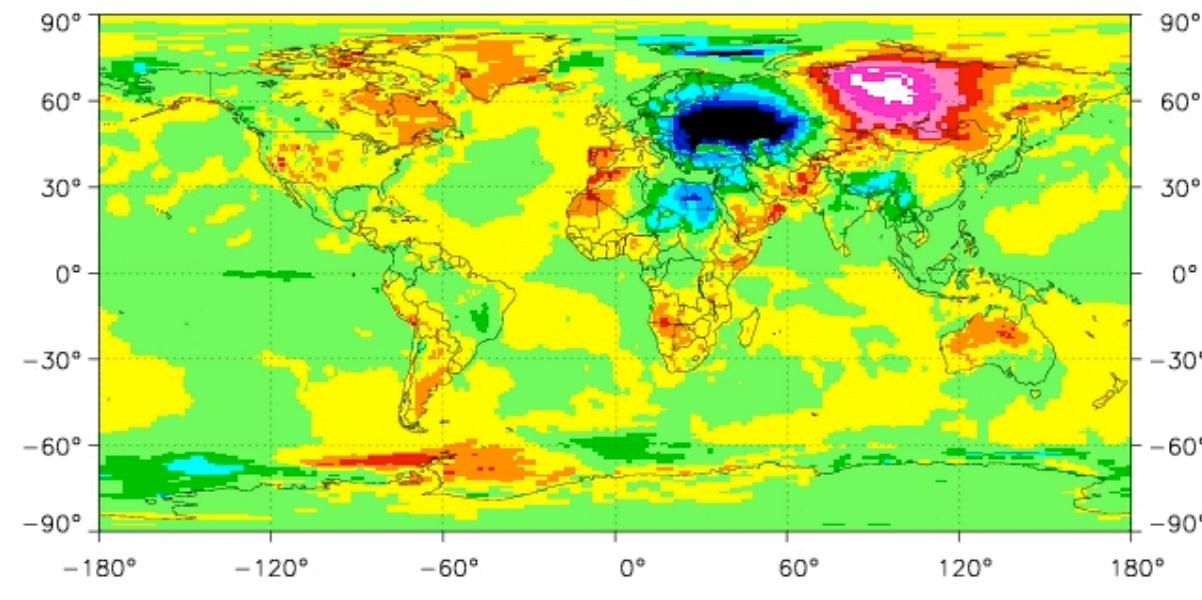


# Longwave Up

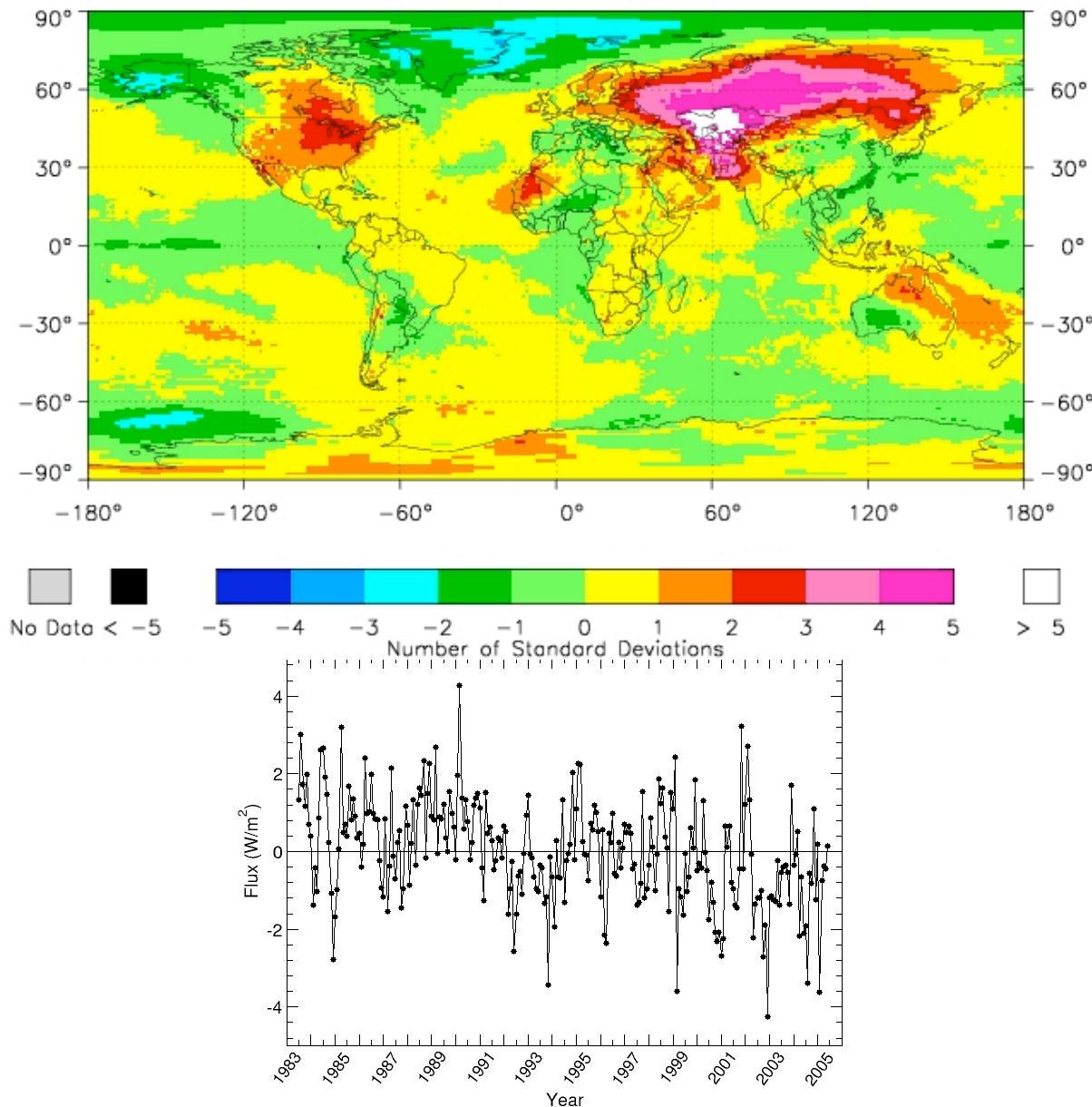
## EOF-5      EOF-7



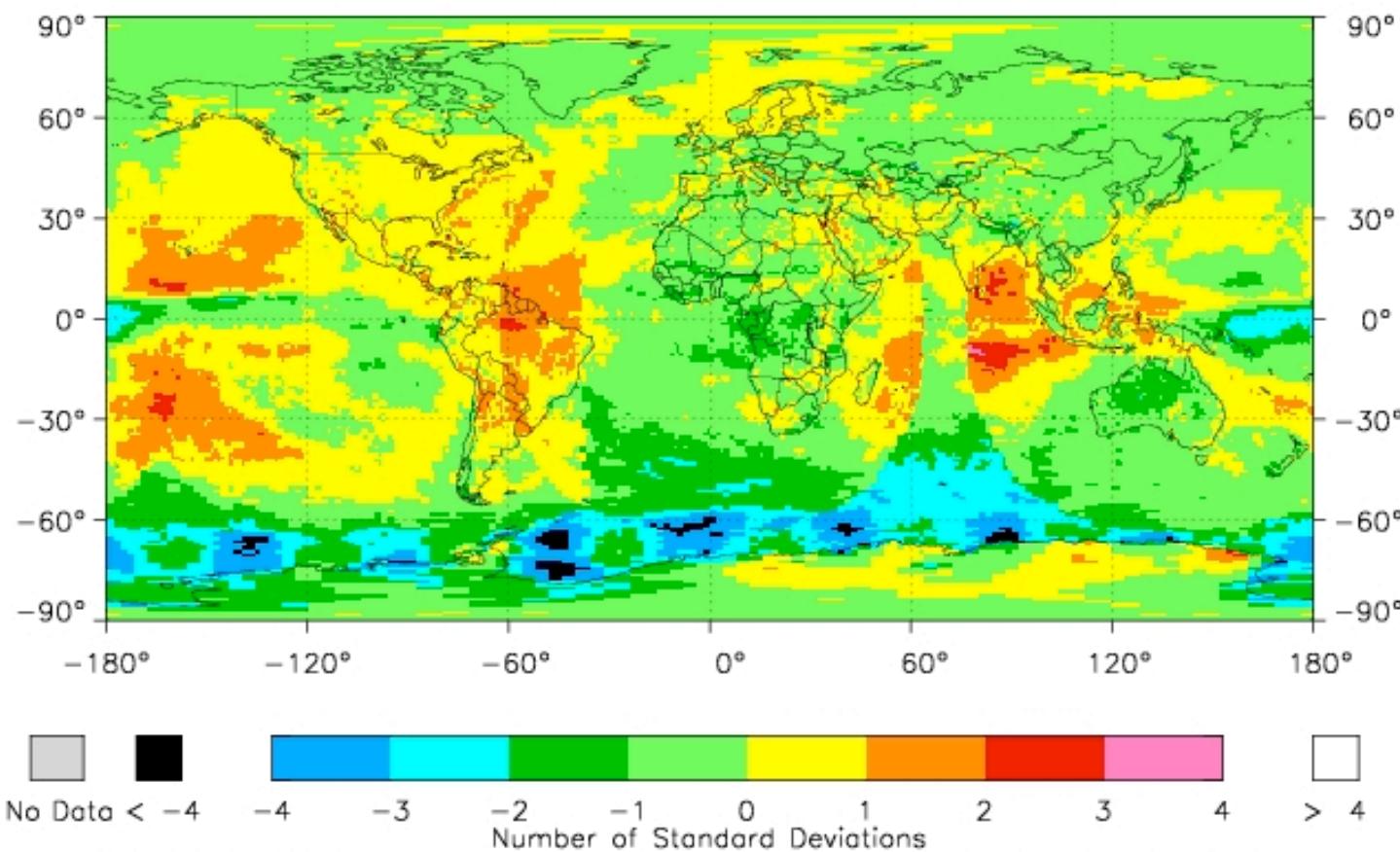
# EOF-8: Longwave Up

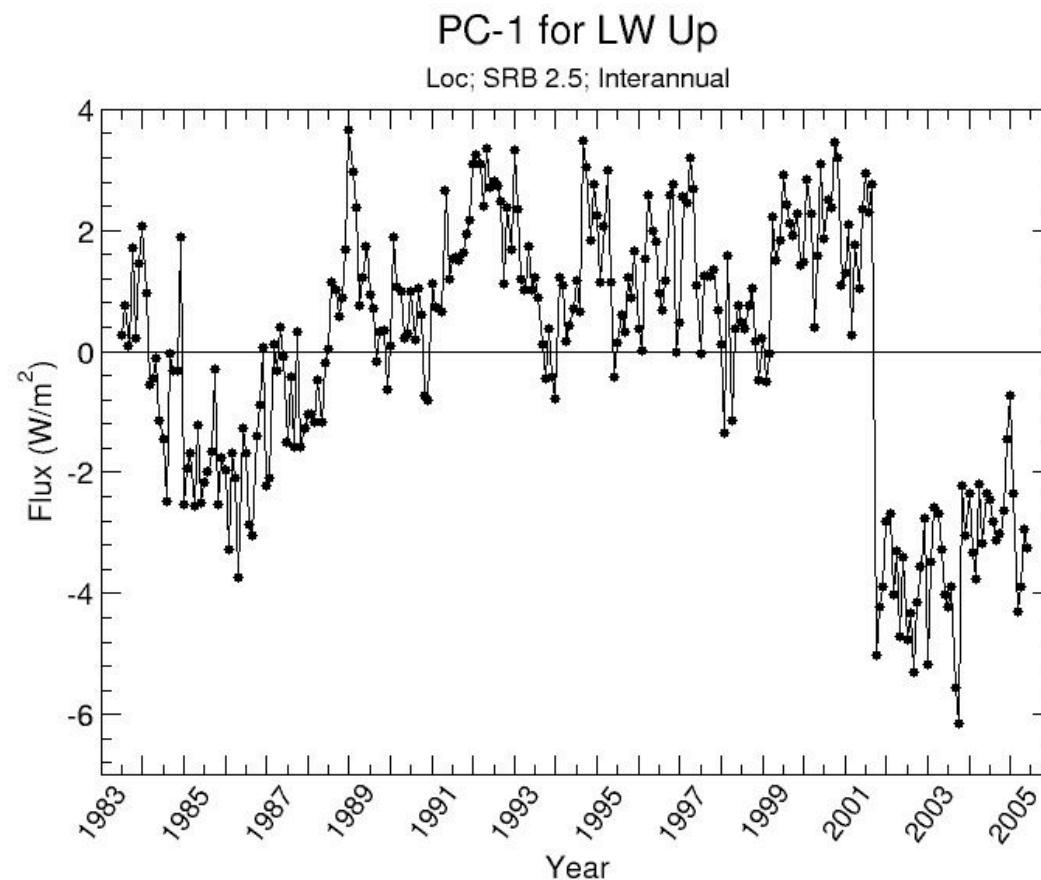


# EOF-4 Longwave Down

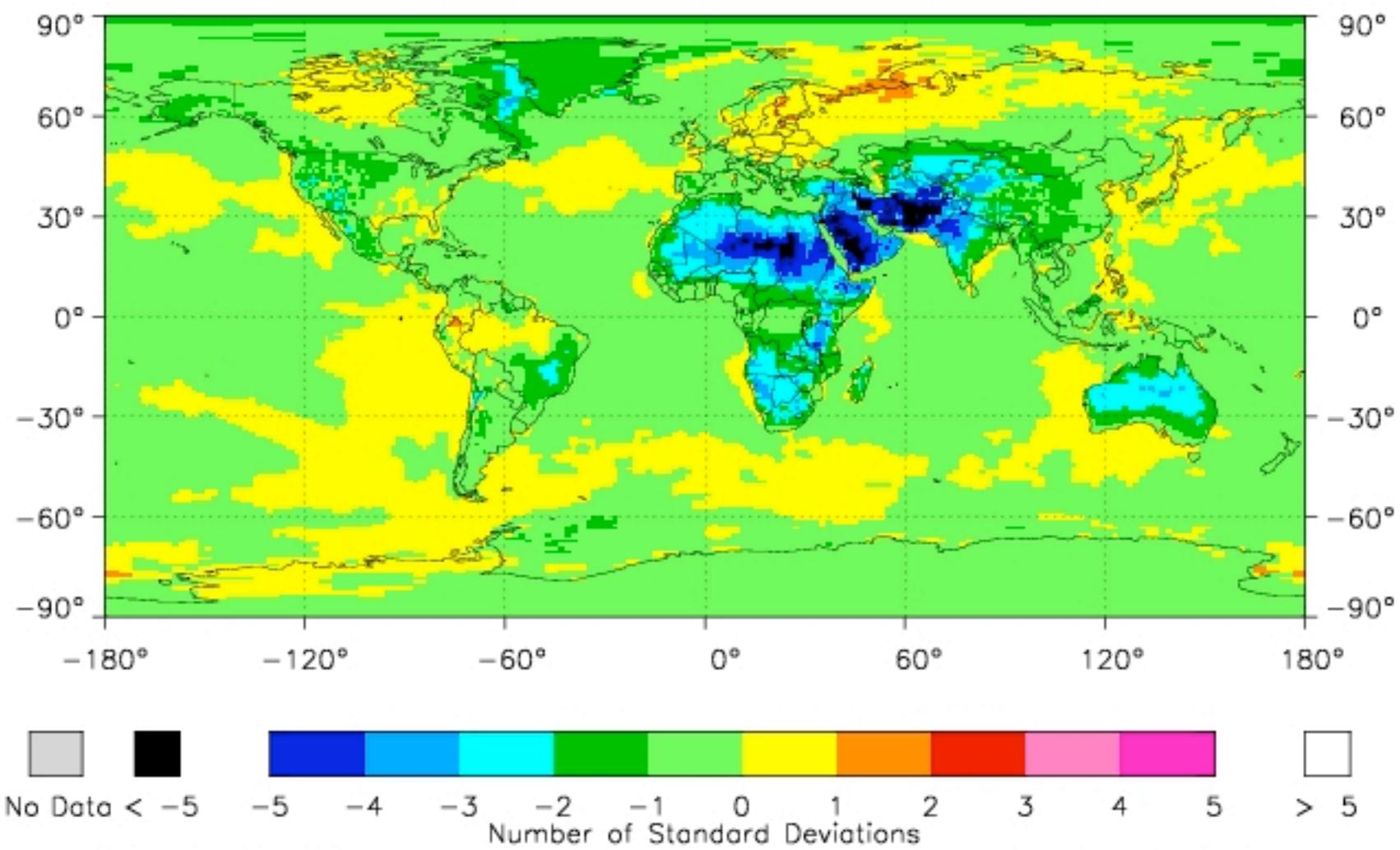


# Artifacts: EOF-2 Shortwave Down





# EOF-1 Longwave Up



# Conclusions

- There are about 40 variations discernable in SWD, LWU and LWD.
- For SWD, EOF-1 and -3 describe ENSOs.
- Artifacts are clearly shown, especially due to Satellite availability.
- Indian Ocean activity is strong (IOD?)
- SWD EOF-8 shows variations of clouds near Brazil.

# Conclusions (Continued)

- LWD EOF-4 and LWU EOF-5 and -7 show North American/Central Eurasia Dipole.
- LWU EOF-8 shows Europe/Asia Dipole.
- Near Equator lack of Coriolis Force results in small variations of Pressure Heights, so that SWD and LWD are more sensitive to processes than Pressures.

# Future Work

- Evaluate effects of TOVS operational sounding algorithm changes and ISCCP skin temperature retrievals.
- Evaluate effects of Observing System changes.